Methane super-emitter detection and identification combining TROPOMI with VIIRS

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Netherlands Institute for Space Research

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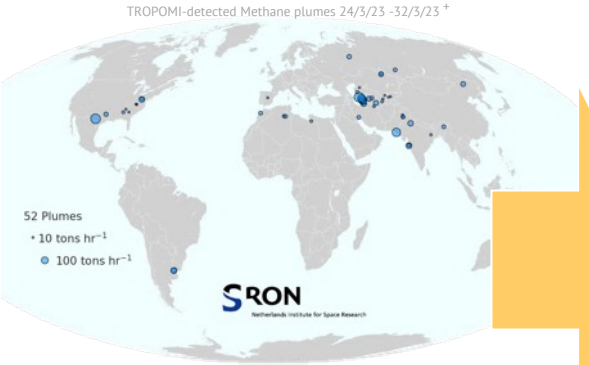
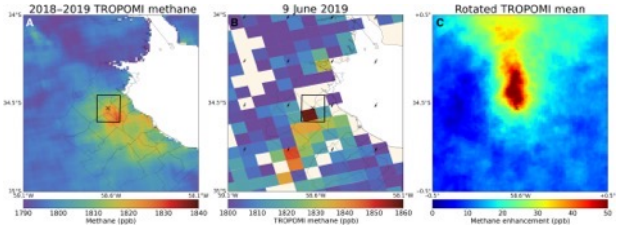
This research has been funded in the framework of UNEP's International Methane Emissions Observatory (IMEO).

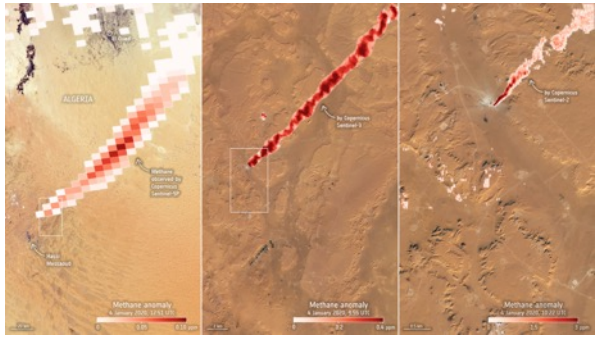
SRON & UNEP-IMEO MARS



Daily ML-based plume detections

Weekly plume detections available at:
https://earth.sron.nl/methane-emissions/





Determine source locations using:
- Wind-rotated TROPOMI data
- Facility information
- Point source imager data
- (But a lot of super-emitters are (very) intermittent!)

UNEP-IMEO Methane Alert Response System

(Targeted measurements using PRISMA, EnMAP, Sentinel-2, Landsat)

Methane
Detect and Attribute

Alert
Notify and Engage Stakeholders

Response
Stakeholders Take Abatement Action

System
Track, Learn, Collaborate, Improve

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Schuit et al. 2023 https://doi.org/10.5194/acp-23-9071-2023
Maasakkers et al. 2022 https://doi.org/10.1126/sciadv.abn9683
Pandey et al. 2023 https://doi.org/10.1016/j.rse.2023.113716

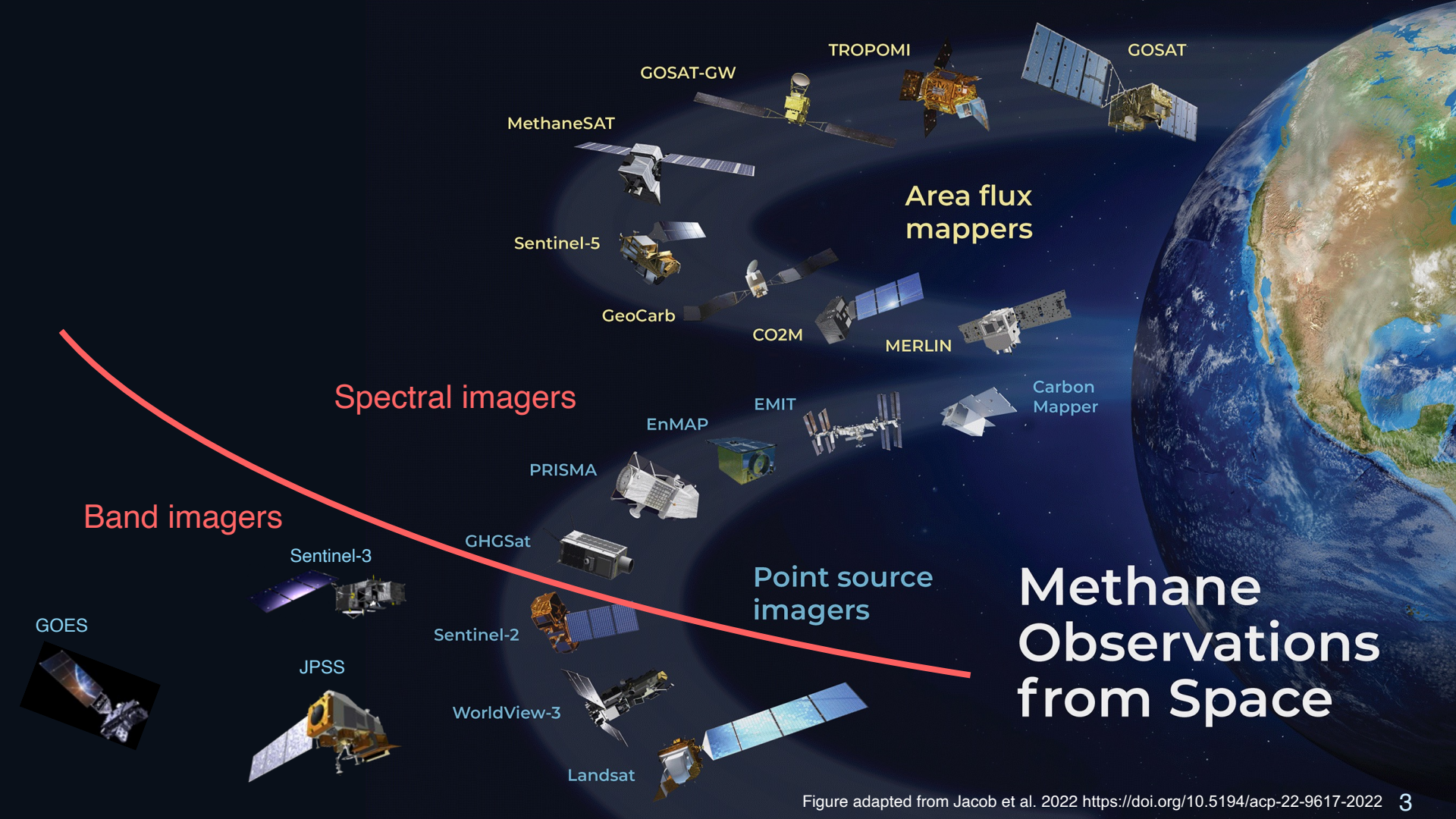

Figure adapted from Jacob et al. 2022 https://doi.org/10.5194/acp-22-9617-2022

Why use (yet) another satellite/instrument to monitor methane emitters?

- ✓ We have TROPOMI!
- ✓ Tip & Cue with GHGSat, TANGO, PRISMA, EnMAP!
- ✓ Tip & Cue with Sentinel-2!
- ✓ Sentinel-3: daily coverage!

- ✓ VIIRS can help with all of that.

- But the resolution isn't… great
- Targeted data only available after the fact
- Revisit time of 5 days
- Knowledge gaps:
  - Transient events
  - Influence wind data
  - Accuracy of MBMP

Everything that follows is preliminary, currently under peer review.
Preprint available at: https://eartharxiv.org/repository/view/6651/

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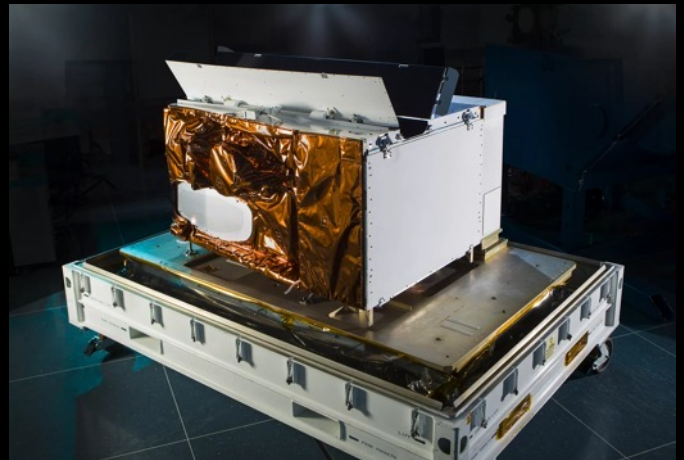
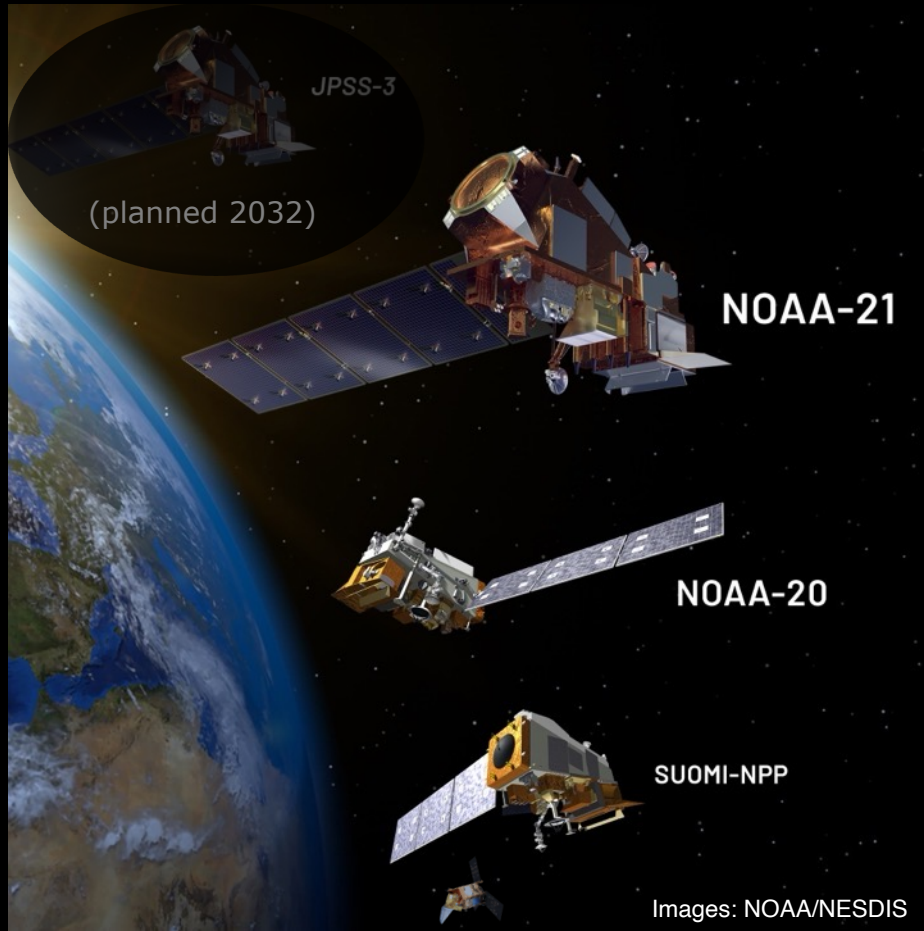
Visible Infrared Imaging Radiometer Suite (VIIRS)

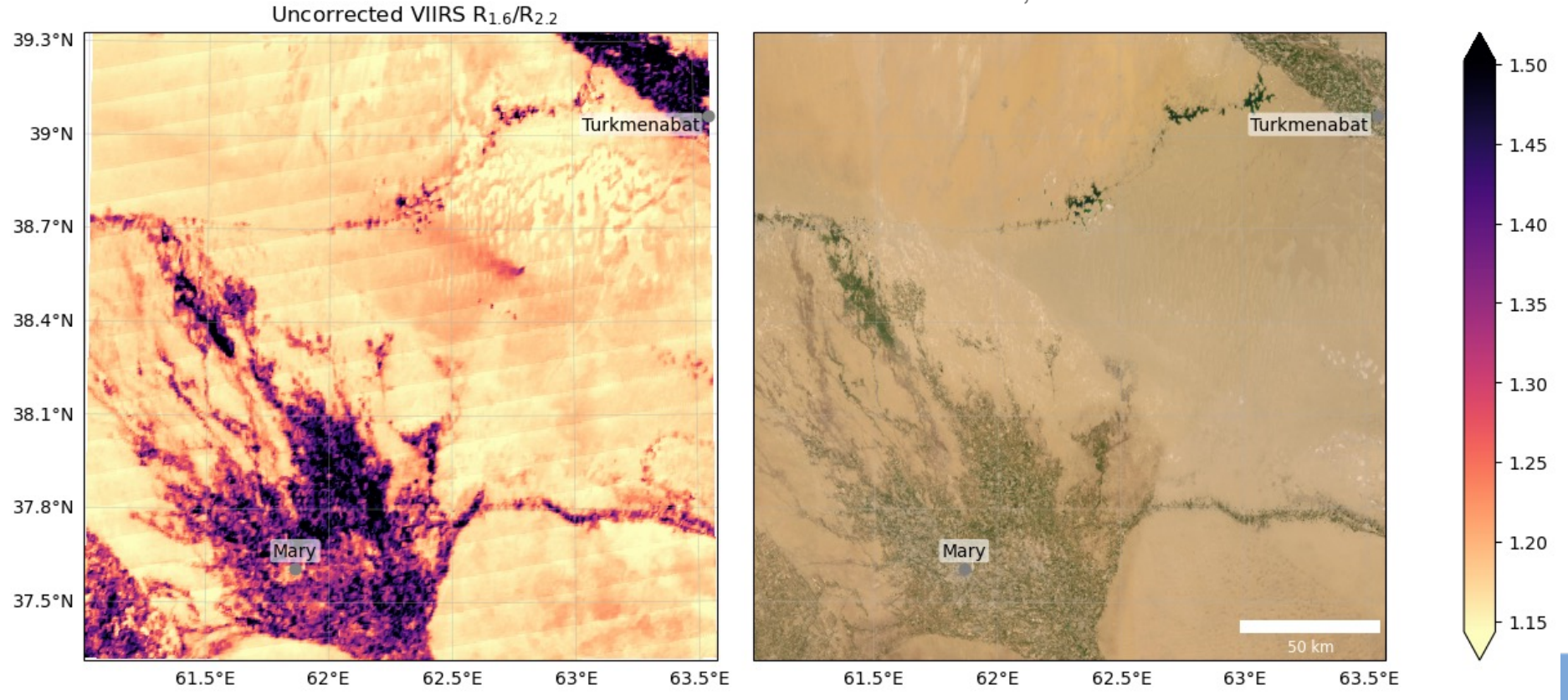
- 3000km swath, whiskbroom scanner
- 750m resolution in 16 moderate-resolution bands
- 1.6μm and 2.2μm SWIR bands (similar to Sentinel-3 SLSTR)
- SUOMI-NPP overpass within 4 minutes of TROPOMI





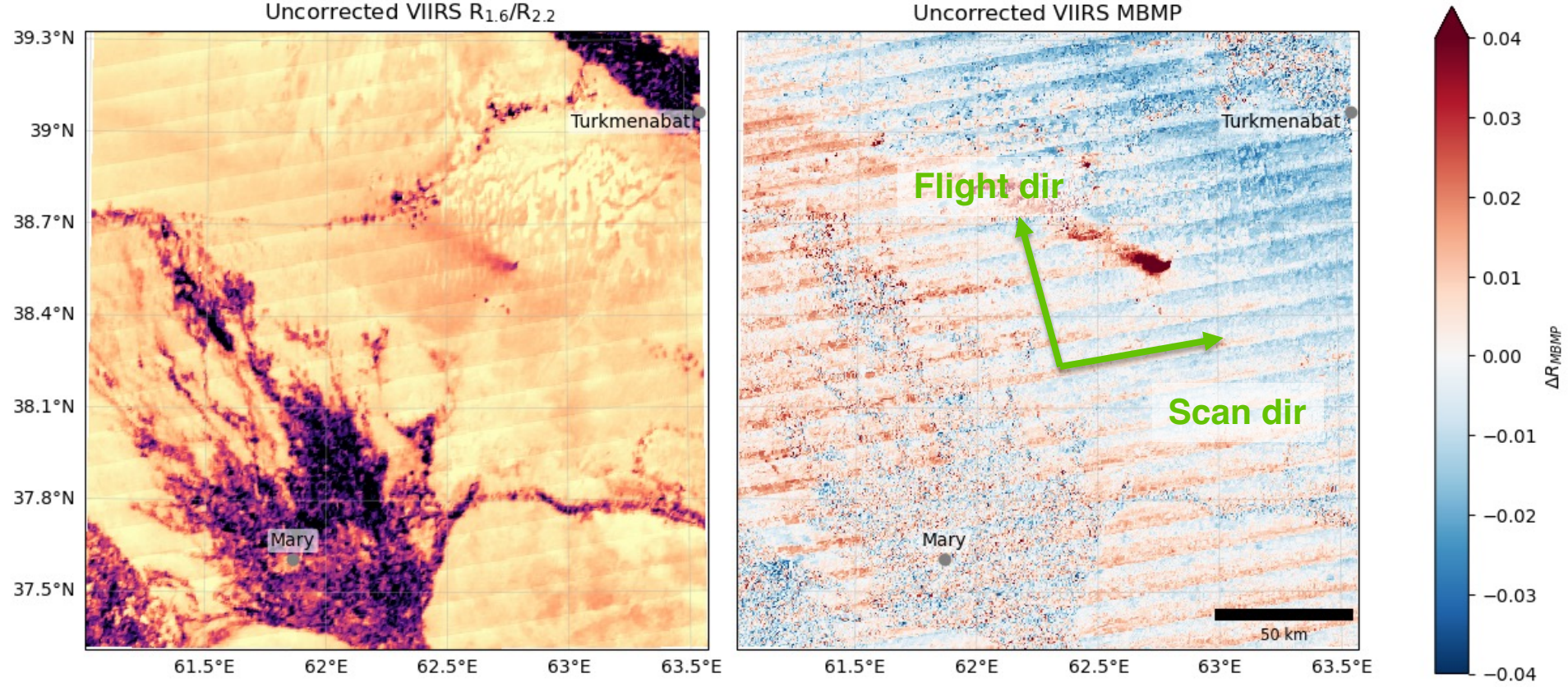
Measuring methane with VIIRS

October 2, 2023



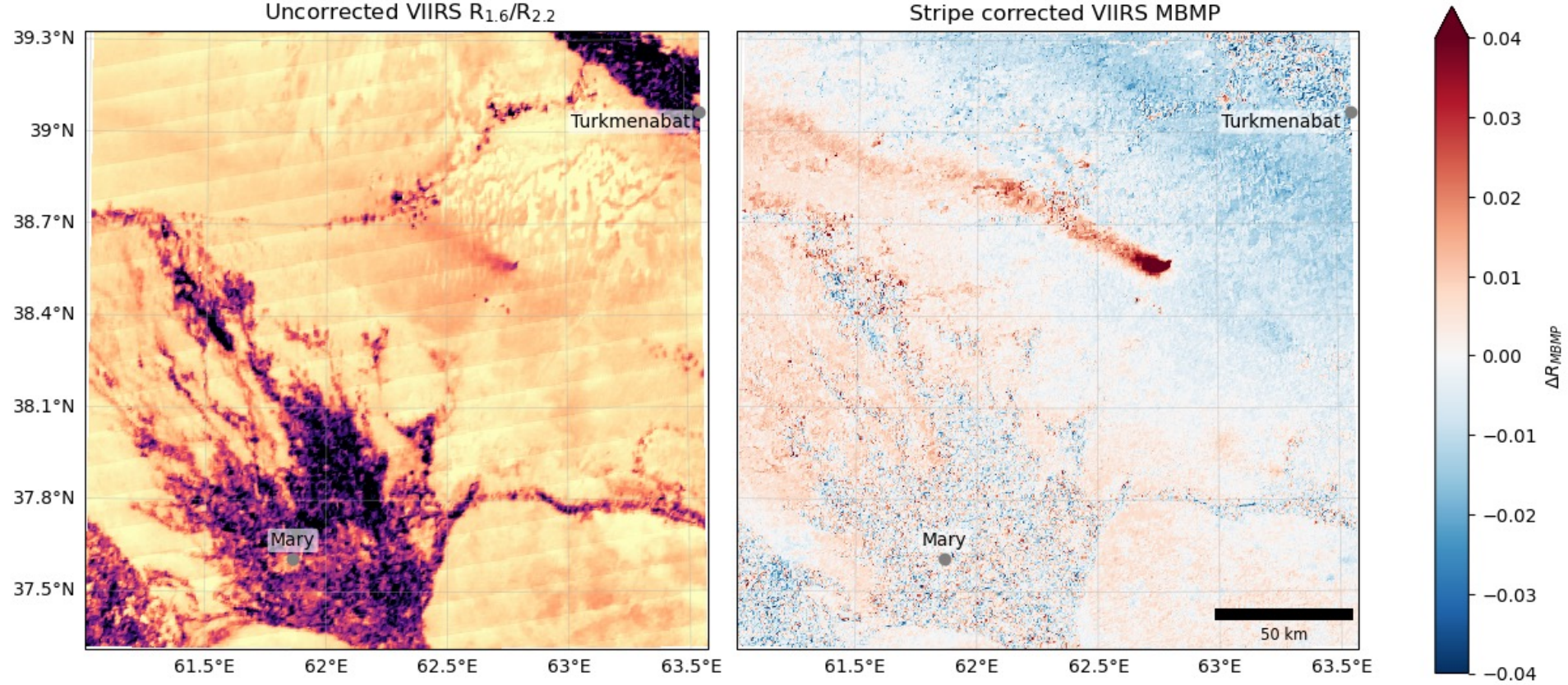
Measuring methane with VIIRS

- Whiskbroom scanner has 16 detectors for each band…



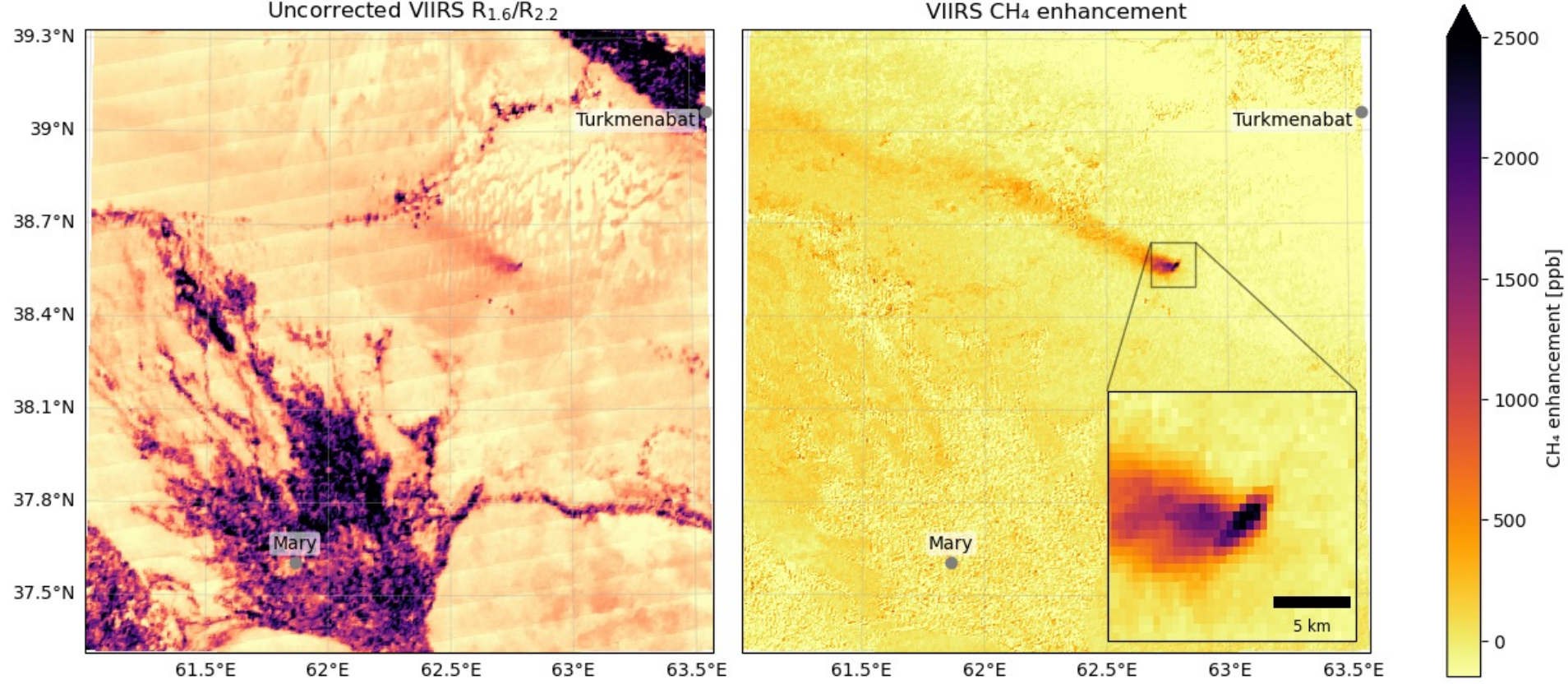
Measuring methane with VIIRS

- Correct by fitting per-detector gain and offset on each band separately



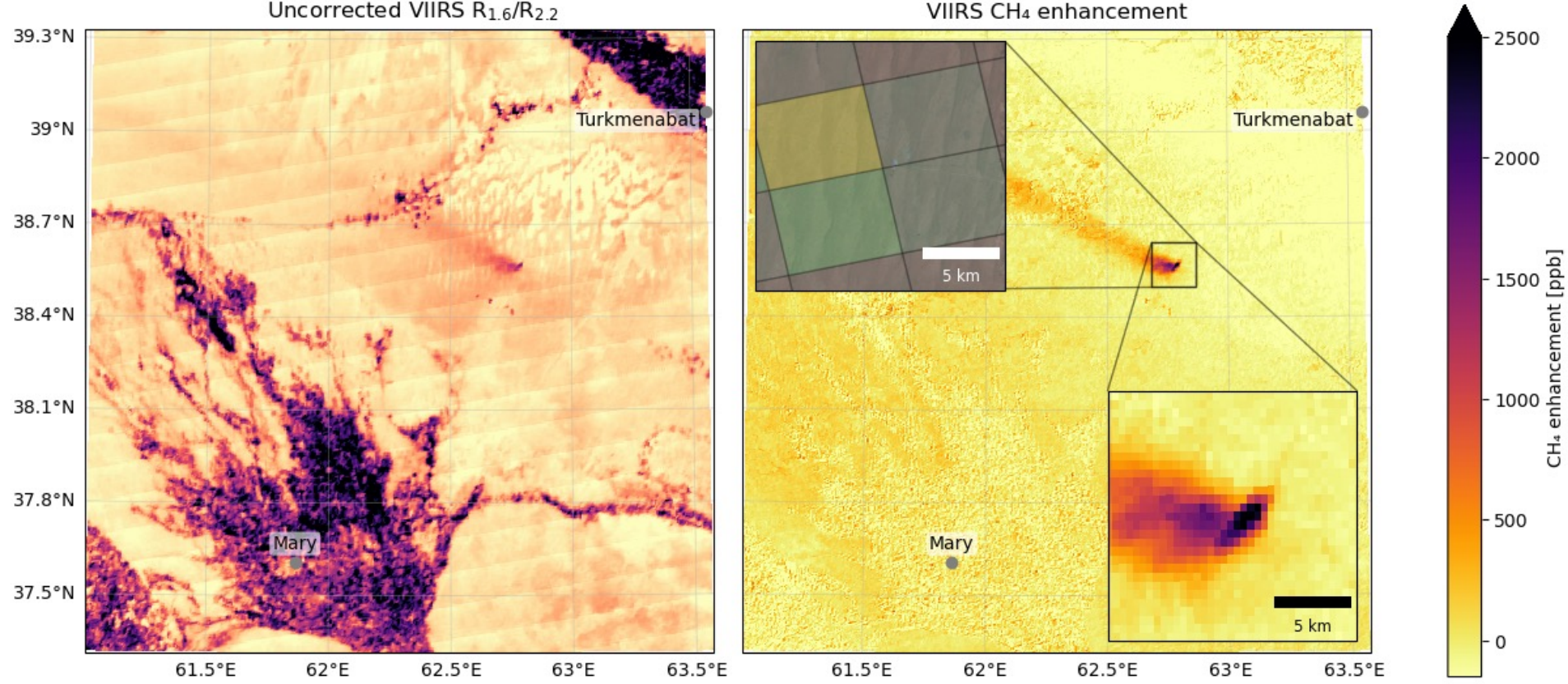
Measuring methane with VIIRS

- Clear-sky radiative transfer simulation



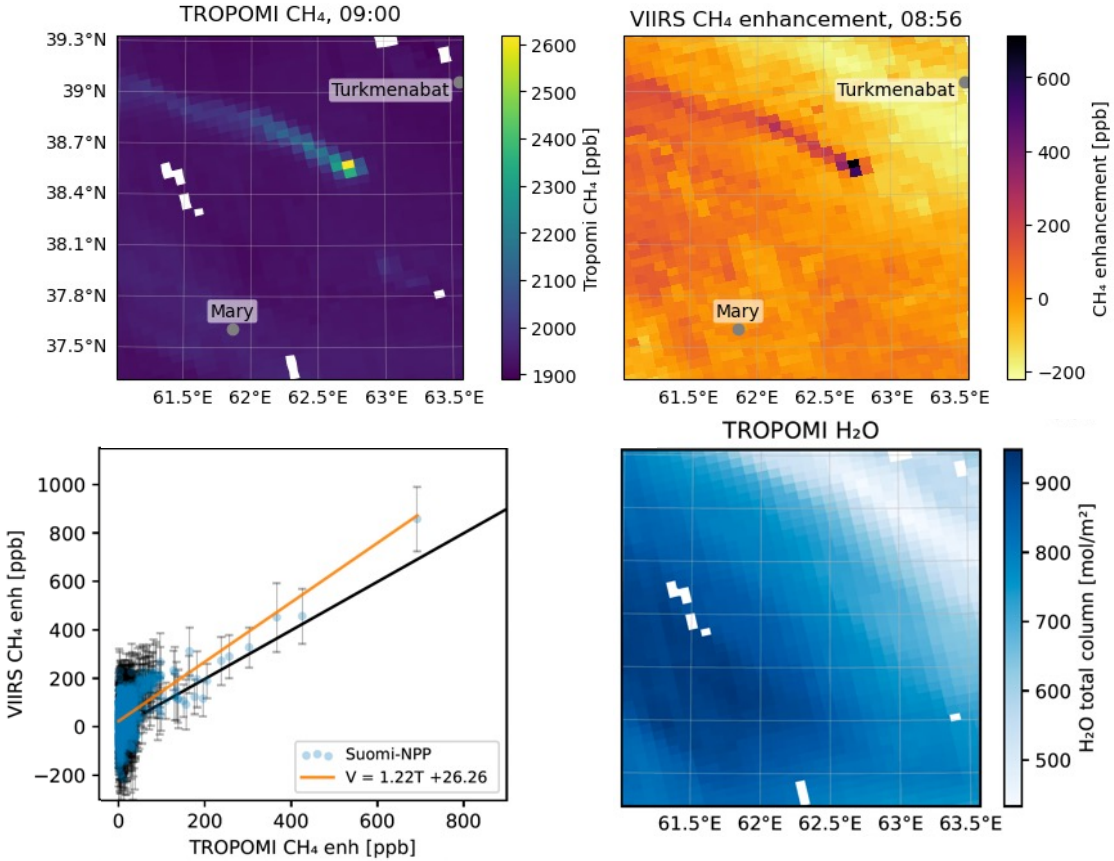
Measuring methane with VIIRS

- Clear-sky radiative transfer simulation



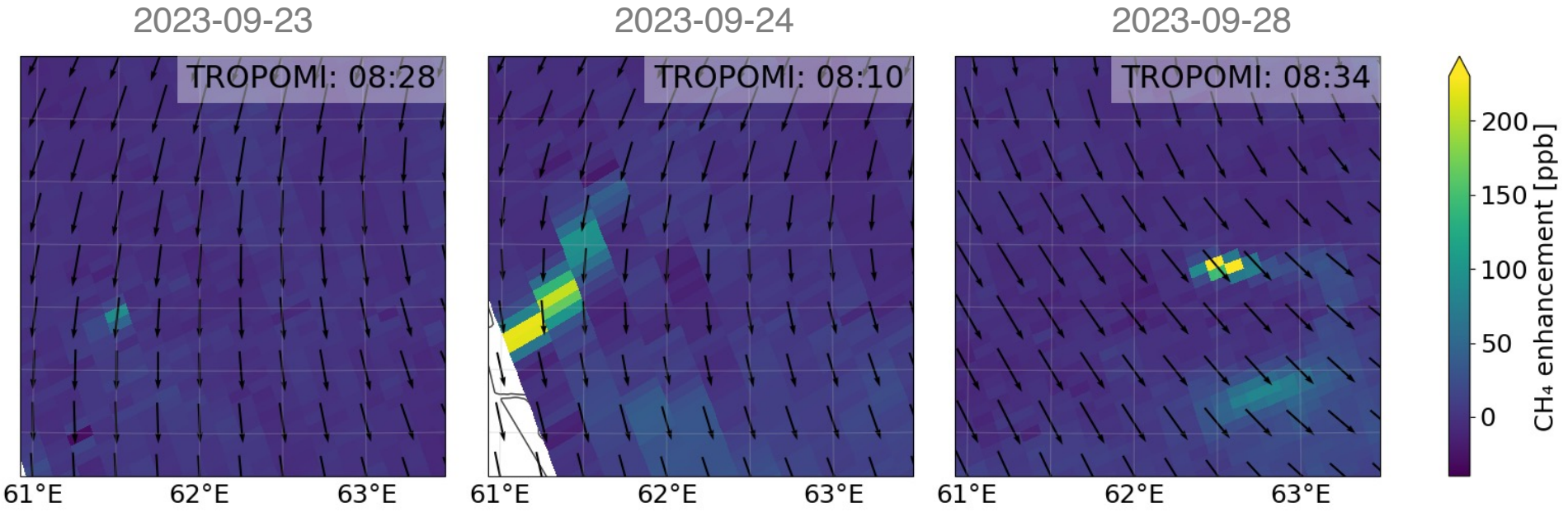
Cross-validation

- Resample VIIRS data to TROPOMI pixels
- Directly compare Suomi-NPP VIIRS CH_4 enhancements with TROPOMI CH_4 enhancements
- Other gases?



Source localization: Turkmenistan

- Different days
- Three plumes
- ~80 km apart



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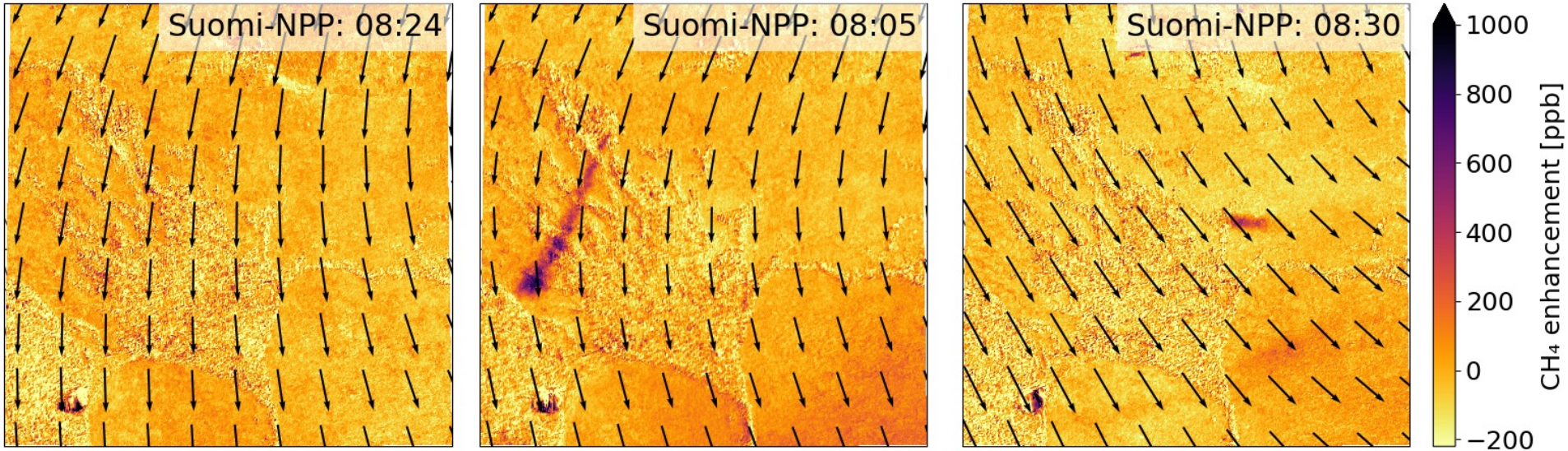
2023-09-23 2023-09-24 2023-09-28



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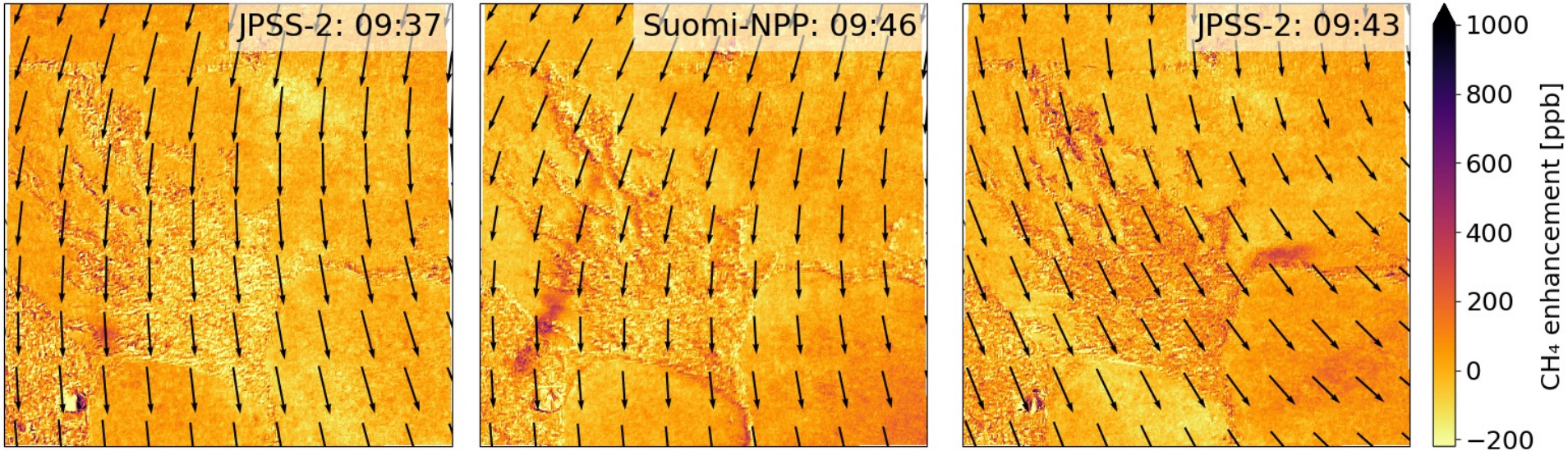
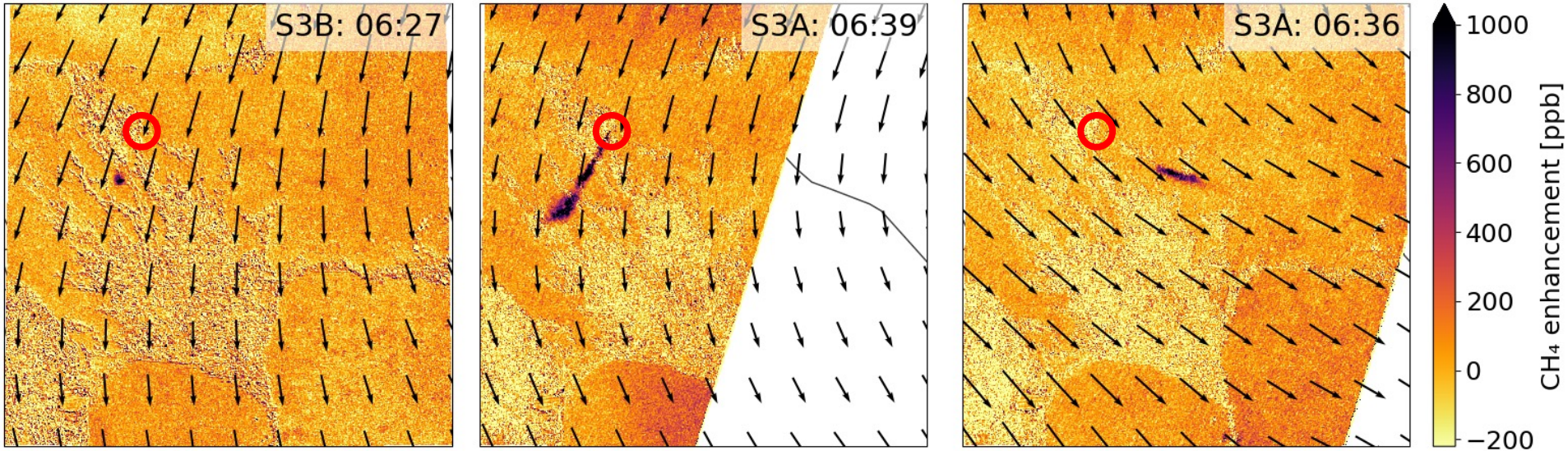


Source localization: Turkmenistan

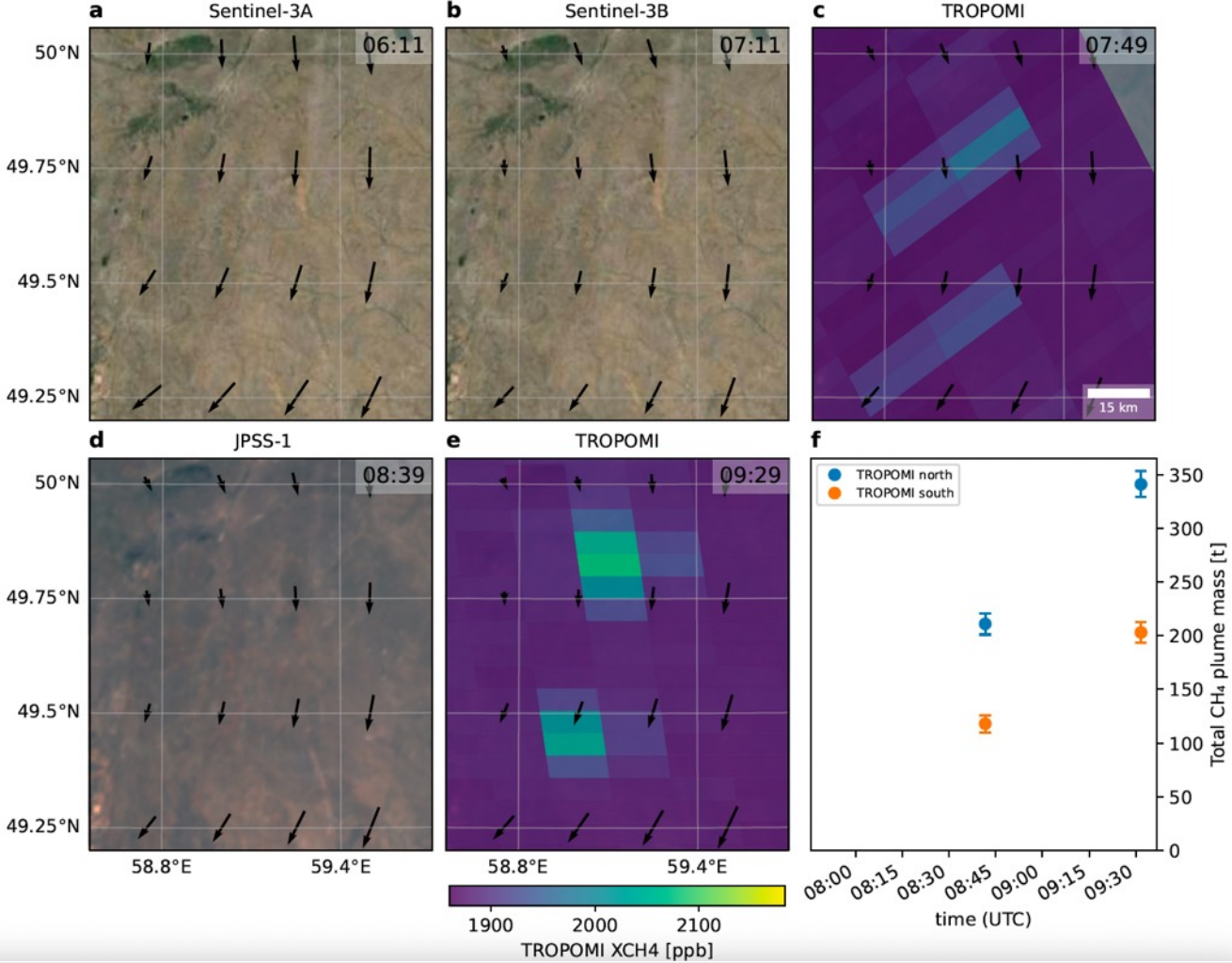
- Different days
- Three plumes
- ~80 km apart
- Backward in time

2023-09-23 2023-09-24 2023-09-28



Kazakhstan

Two block valve stations
May 14, 2021

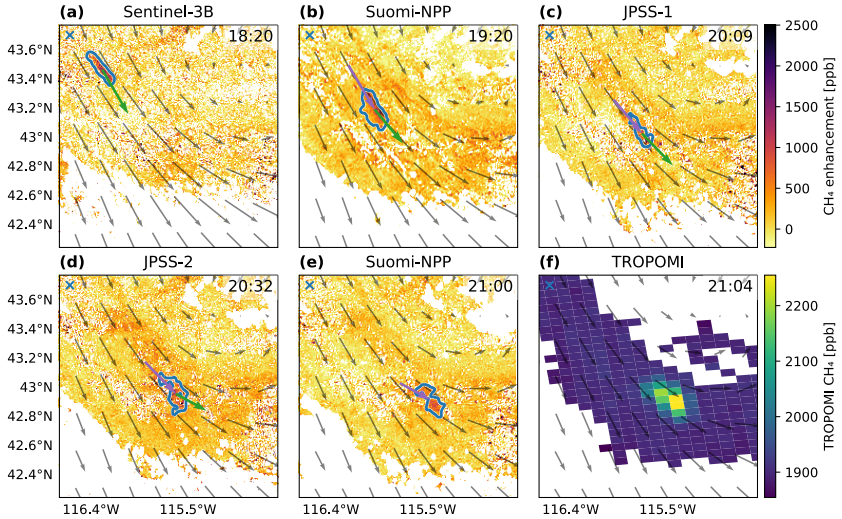


Extracting properties

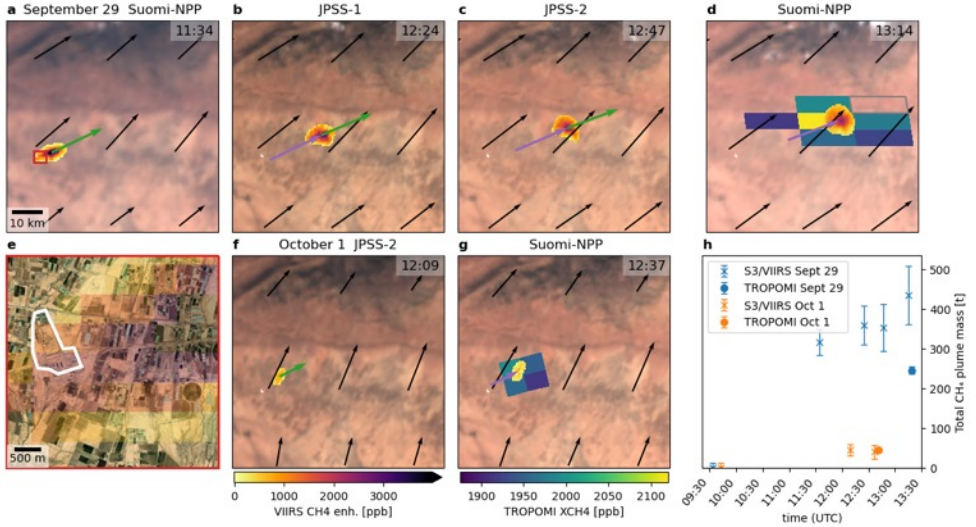
- Effective wind velocity
- Plume mass

Middleton, Idaho, USA

798±174t CH_4 (TROPOMI: 900±30t)
(GOES[1]: 851±110t, Operator[2]: 900t)

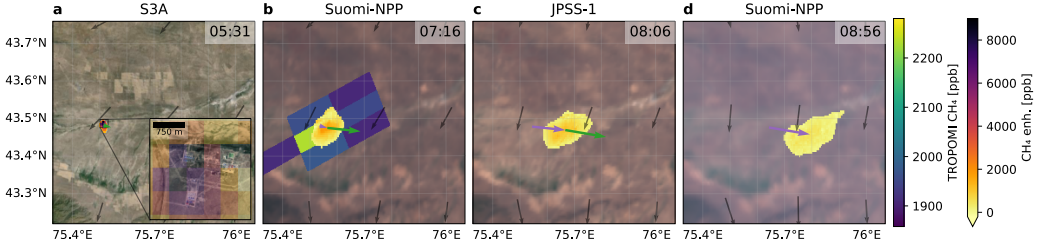


Algeria



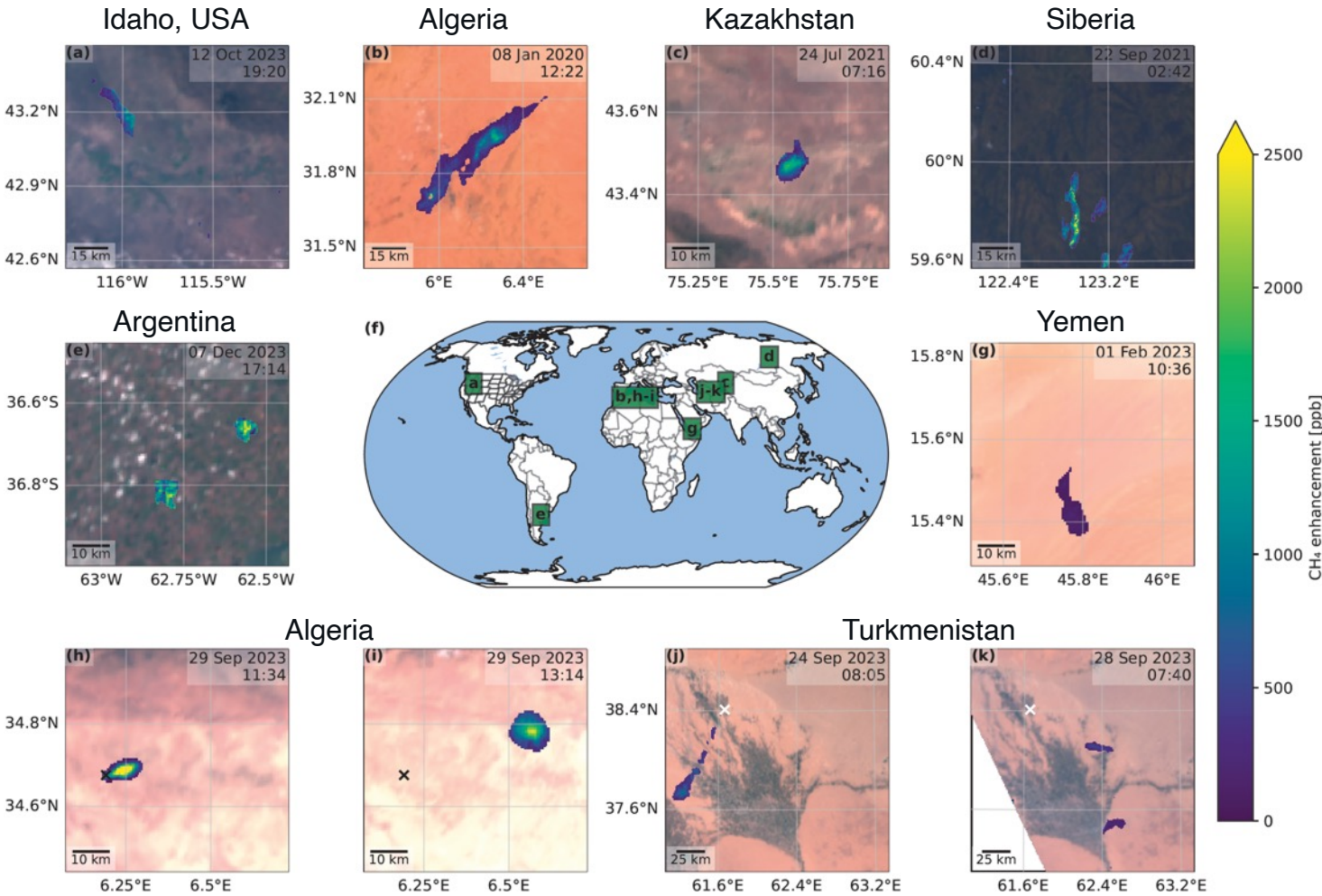
East Kazakhstan

254±48t CH_4 (TROPOMI 258t)



[1]: https://methanedata.unep.org/plumemap
[2]: https://www.bloomberg.com/news/articles/2024-01-23/us-examines-why-williams-took-65-minutes-to-halt-a-methane-leak

VIIRS + TROPOMI can pinpoint transient methane emissions globally.



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